Malaria risk in Dakar : socio-spatial inequalities and urban environment

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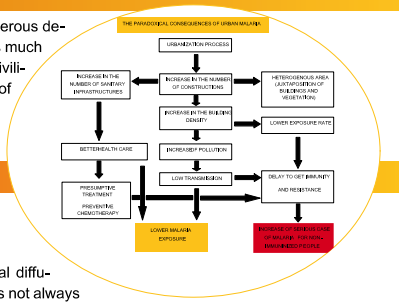
Introduction

Considering malaria, it's difficult to establish causal links and to organize the numerous decisive factors of the disease into a hierarchy. Concerning malaria in urban areas is much more complex for one can find a great variety of micro-landscapes, populations, civilizations, believes and social-economical status which modulate the geography of transmission and make it more complex. Urbanization restrains the paludal development; it leads to a depleted but more heterogeneous transmission.



Methodology

From Social Geography...

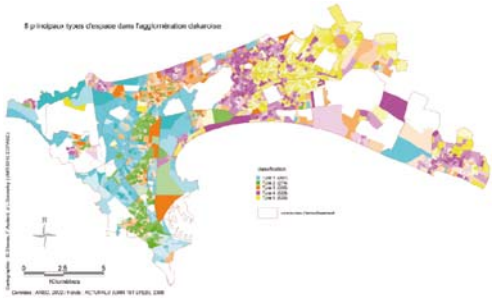
The term "environment" has several different meanings and covers many different realities. Its acceptation raises questions about physical environment, morphological characteristics of the city and the social and cultural dimensions of its populations. Therefore, one of the issues of ACTUPALU is the characterization of urban areas.

The database results from a survey by questionnaire, about the behaviour of 3000 households. These households were chosen according to a sampling that respects the diversity of the social characteristics of the population in Dakar, and that integrates the geographical dimension of the city space. About 50 questions were asked, divided up into two different questionnaires. The first questions were asked to a household about the characteristics of its members, its habitat and the home environment as well as about its monetary, hardware resources and expenditures. The second questionnaire was filled by "one" woman of the household and deals with the following modules: psychosocial aspects of health, cultural, and socio-demographic characteristics, mobility, social networks, knowledge and attitudes about health and disease, perceptions about the neighbourhood health structures and the use of health care services during the last infantile fever crisis.

These data are eventually input into a GIS, and then processed and brought together according to some indexes (economists create a synthetic index of poverty), or to some multi-varied statistic processes (correlation and factorial analysis). But for the moment we cannot introduce the processes, which are still in progress.

At last, they will indicate environmental and socio-behavioural factors of the P. falciparum infection risks in Dakar and its suburbs (over 2009 and 2010).

The interest and the newness of this database can also be found in the fact that it takes into consideration the "grand Dakar". And it is precisely interesting to study the urban fronts, the suburbs and the urban expansion areas of Dakar. These complex places are at the interface of high population density and epidemiologically active zones.



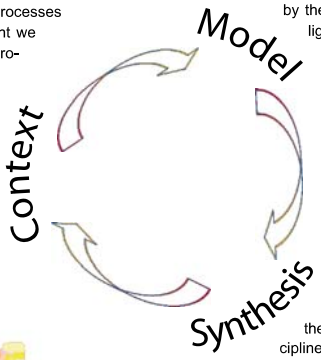
Mapping socio-economic diversity in Dakar

... to Urban Ecology

The observation of the spatial diffusion mechanisms of malaria is not always sufficient for their comprehension and consequently can be relayed by the setting up of theoretical and methodological system.

The complexity of nonlinear contact between the vector and people who may be infected and then between this very vector and its biotope can be modelized by a multi-agent system. The complex "modelized" system represents local dynamics by autonomous entities that can interact with each other and their environment. The heterogeneity of individual behaviors due to social, economical and environmental factors generates some global dynamics by means of interactions, and that are made noticeable by simulation software. The computer modelling of the heterogeneity in intra-urban area and of the forms of mobility associated to the diffusion of a pathogenic agent makes the distinction between three dynamic systems. These are (as illustrated by the figure seen below): the people who can possibly be infected, the vector which is originally the cause of the diffusion and the urban environment namely the support and contact area of the two previous systems.

These three systems interact with each other and produce the dynamics of diffusion. It is still necessary to specify the variables taken into account by the simulation. Eventually, such a modelling allows to shed light on the individual behaviors, the interactions between the human being and the vector, and the spatial structure effects on the spread of pathology.



Linking socio-spatial characteristics by creating an index of risk

The aim of this methodological work is to create an index of paludal risk which would tend to include various factors of environmental risk. It results in connecting the two aspects of research previously declined. Even if problems prove to be numerous: scalar, temporal or more technical, balance of factors according to their respective importance; it seems that geography as a discipline is likely to be connected with and to connect other disciplines in which the idea of a space is necessary.

The following illustration shows the outline of the risk index expected and will be compared and mapped at the 3000 households scale and at a larger scale like IRIS or district (which will require data interpolation by kriging).

Having crossed this information allows a more precise idea of exposure to risk of transmission without obscuring the complexity of the pathogen system. Moreover, given the difficulty of prioritizing the different factors of malarial risk, the index enables us to consider the majority of factors involved in the geography of transmission except here in matters of immunity.

Outline of the expected risk index at census districts level.

VULNERABILITY	HAZARD
Urban morphology	Urban morphology
Habitat typology (H)	Urban typology (T)
Prevention (picturing of pathology) (Pr)	Flood area (F)
Socio-eco-demographic variables (P)	Soil occupation (S)
	Entomological index

$$I = \frac{a\,\frac{(\alpha H + \beta P + \gamma \mathrm{Pr})}{3} + \mathrm{b}\,\frac{(\delta T + \varepsilon F + \epsilon S)}{3}}{2}$$

Conclusion

The epidemic spread of malaria in urban setting depends of countless factors. This kind of research shows, quite rightly, the interest and the difficulty to link social aspects and the "geographic" ones. Moreover it is necessary to mention the extreme variety of custom and social practice on a small scale, in an environment densely populated and also really heterogeneous. Urban environment studies involve a multi factorial reasoning, close to what the social sciences approach should be.

Also, a re-emergence of malaria in the north part of Mediterranean Sea will give rise to sanitary situations different from the ones studied. Social and societal situations actually remain beyond compare. Following-up European places which is necessary for vectorial monitoring is not the only thing at stake. In these areas the risk is indeed as political as sanitary. The crises are always more or less correlated with the implementation of the precautionary principle and public awareness campaigns (without generating paranoia).